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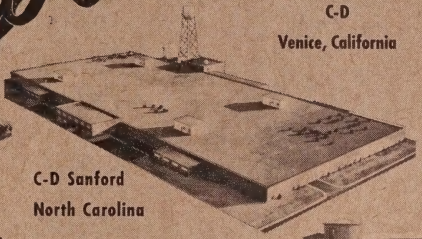

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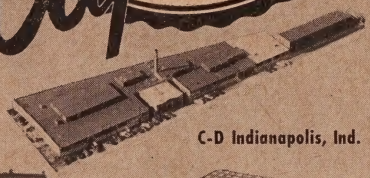

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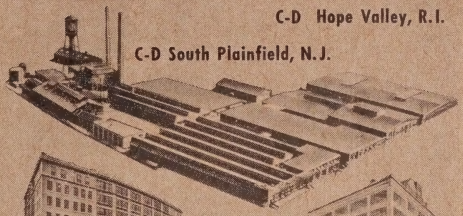

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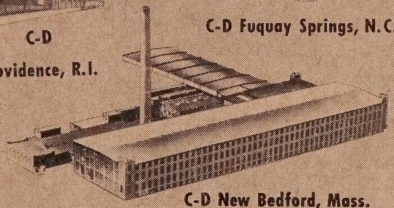

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Vol. 22 JUNE, 1957 No. 6

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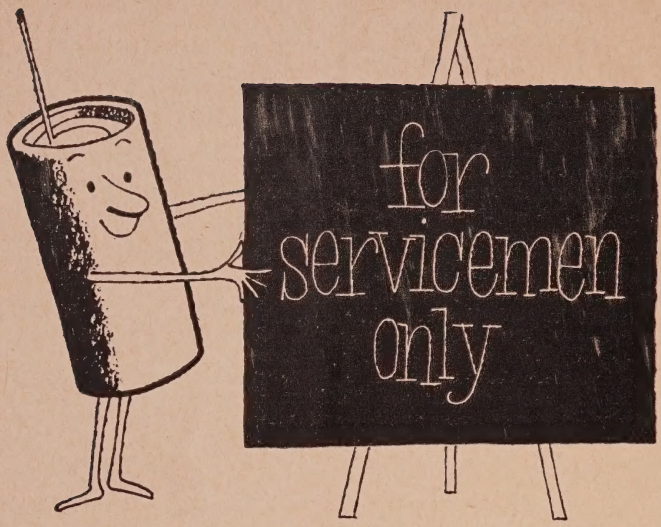

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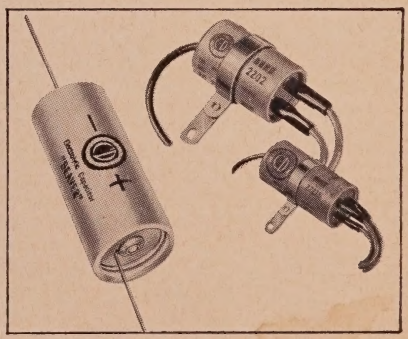

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APPLICATIONS OF POWER TRANSISTORS

With power transistors of several types and ratings now available at reasonable prices, considerable interest concerning their practical applications has arisen among experimenters. However, very little practical data have appeared in print. It seems reasonable to expect that the next large period of activity among transistor experimenters will center around the power transistor.

This article describes 10 practical power transistor circuits which have been tested by the Editors. These designs cover a wide range of interest, although they do not, by any means, cover a complete cross-section of applications of these transistors. The circuits have been developed around readily-obtained transistors, especially those which are readily adaptable to amateur and experimental use and are comparatively inexpensive.

Other types of power transistors handle higher currents than those treated in these designs, and will deliver higher power and voltage in circuits of the same general type. At the same time, however, they are not as readily obtainable from supply houses and they cost more. It will be obvious to the reader how the performance limits of each of the circuits shown here might be boosted by substitution of higher-powered transistors.

The circuits given in this article are useful in the configurations shown and for the indicated purposes. Nevertheless the reader may discover readily how they may be modified to suit his individual demands, and also additional applications of the same circuits will suggest themselves.

Class-A Audio Power Amplifier

The power transistor competes immediately with the tube as a power-type a-f amplifier. In this application, it finds use in the output stages of radio receivers and sound amplifiers. Its low d-c voltage requirement (6 to 12 volts) is its principal attraction.

Figure 1 shows the circuit of a Class-A audio power amplifier employing a Type 2N95 **npn** transistor operated at 12 volts dc. This stage has a power output of 0.6 watt and is designed to drive a 3.2-ohm loudspeaker. The over-all power gain is of the order of 23 db, which means that a signal-input power of approximately 10 milliwatts will drive the amplifier to full output. This driving

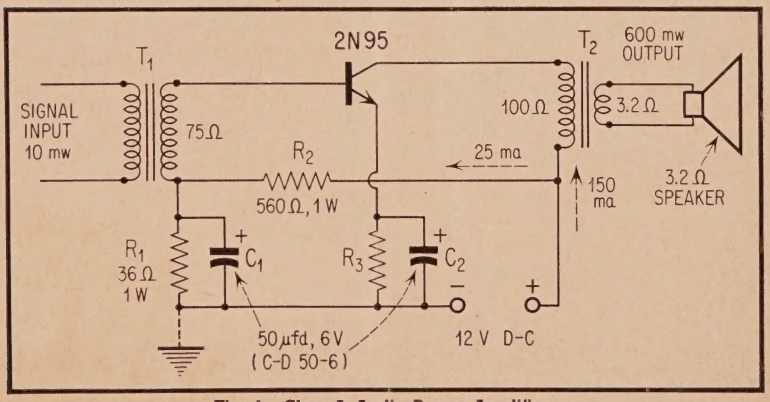

Fig. 1. Class-A Audio Power Amplifier.

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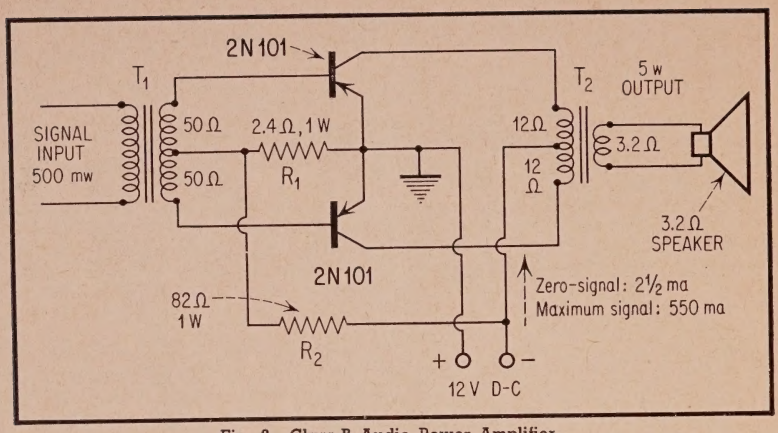

Fig. 2. Class-B Audio Power Amplifier.

power may be obtained from a transistorized preamplifier.

D-c base bias is supplied by the voltage-divider network, R_1-R_2. This fixed voltage, together with the current-limiting emitter resistor, R_3, stabilizes the operating point of the amplifier against the effects of temperature changes and prevents destructive "runaway." Resistor R_3 is bypassed by C_2 to prevent degeneration, and R_1 is bypassed by C_1 to minimize input-signal losses in the bias network.

Transformer T_1 must match the preamplifier (or line) to the 75-ohm input impedance of the transistor. The secondary of this transformer must carry approximately 5 milliamperes dc. The output transformer, T_2, must match the 100-ohm collector output circuit of the transistor to the 3.2-ohm voice coil, and its primary must carry a steady current of 150 ma dc. T_1 can be a small, universal-replacement-type output transformer. A suitable unit for T_2 is Acme Type T-24041.

The total continuous current drain from the 12-volt supply is 175 ma dc. Of this, 150 ma are the steady collector current of the transistor, while 25 ma flow through the voltage divider and transistor base circuit. While this may appear to be a heavy current, the reader is reminded that the filaments alone in a comparable tube-type circuit would draw equal or higher current. Operation of this amplifier is entirely economical in such intermittent applications as intercoms, where current is switched-on only during actual periods of use.

Class-B Audio Power Amplifier

In Figure 2, two Type 2N101 transistors are operated push-pull in a Class-B audio power amplifier circuit. As in tube circuits, Class-B operation gives the advantages of higher power output, higher efficiency, and more economical use of the dc supply.

The power output of this amplifier is 5 watts. The over-all power gain is 10 db, which means that an input-signal power of 500 milliwatts will drive the transistor to full 5 watts output. This driving power may be obtained from a transistorized preamplifier having a ½-watt output stage similar to the Class-A amplifier shown in Figure 1.

With no signal input, the total current drain from the 12-volt dc source is approximately 142 milliamperes. This is divided between the zero-signal collecter current (approximately 2½ ma total) and the bleeder current through the base-bias stabilizing network, R_1-R_2. On full

signal input, the total collector current swings to 550 ma.

Enough d-c base bias is provided by the voltage-divider network, R_1-R_2, to correct for cross-over distortion but not so much as to bias the transistors nearer Class AB than Class B.

Output transformer T_2 must match the 12-ohm collectors to the 3.2-ohm voice coil. A suitable commercial transformer is Acme T-24043. Input transformer T_1 must match the pre-amplifier output (or line) to the 50-ohm base-input circuits of the transistors. A suitable commercial component for this position is Acme T-24042. This transformer has a primary impedance of 100 ohms and thus is suitable for terminating a 100-ohm line or for working out of a common-collector (emitter-follower) transistor amplifier stage.

The transistors should be provided with heat sinks to permit rapid removal of heat during operation. Bolting them to the metal chassis usually will suffice. However, they must be insulated electrically from the chassis (for example, with 2-mil-thick mica washers), since their metal cases are connected internally to the collector electrodes.

A-F Emitter-Follower

The circuit shown in Figure 3 is equivalent to the tube-type cathode follower. While it is not an **exact** counterpart, it is similar to the tube circuit in the following respects: (1) Input impedance is higher than output impedance, (2) low output impedance, (3) no phase reversal, (4) good frequency response, (5) significant power gain, and (6) voltage gain less than 1.

The **emitter-follower** is so named because the emitter is the output electrode and follows the base-input electrode in signal variations. Here, the output-signal voltage is developed across the 10-ohm resistor, R. The input impedance of the circuit, measured at 1000 cycles, is approximately 400 ohms.

Power gain is approximately 12 db, which is 16 times. Voltage gain is approximately 0.5, and improves with higher values of emitter resistance. Total drain from the 12-volt dc source is 150 ma. Power output of the stage is approximately ½ watt. Driving power is approximately 32 milliwatts.

The emitter-follower is useful as an impedance transformer providing power amplification. It finds application as a low-impedance driving source for small motors and other electromechanical components within ist power-output rating.

Electronic Megaphone

Figure 4 shows a simple audio power amplifier permitting good voice amplification and loudspeaker reproduction in a small, portable **megaphone** unit. The 2N102, **npn,** power transistor delivers 0.6 watt output

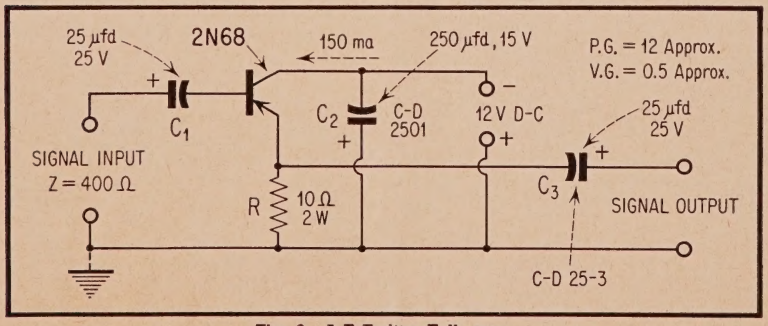

Fig. 3. A-F Emitter-Follower.

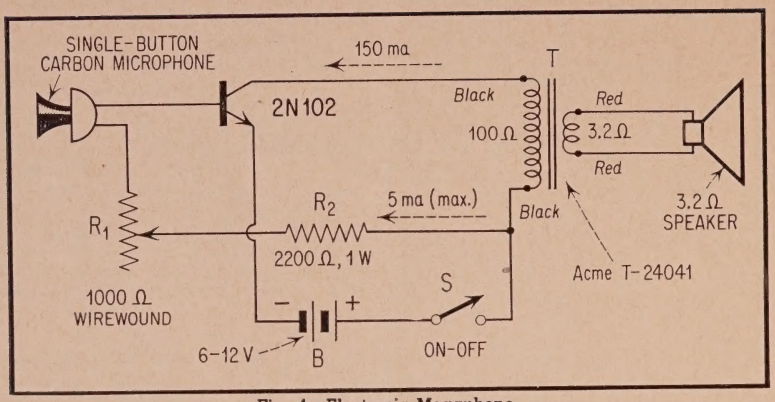

Fig. 4. Electronic Megaphone.

with 12 volts dc supply, and somewhat less a-f power at lower voltages down to 6 v dc. The operating point of the circuit gives Class-A operation at 12 volts.

By employing a carbon microphone, it is possible to operate the single-stage amplifier in this manner without a preamplifier and to obtain full power output. The low-impedance microphone modulates the d-c base current of the transistor. The mean level of the base-microphone current is adjusted with rheostat R_1 which is set for maximum, steady d-c collector current of 150 ma at 12 volts. This is not a volume control.

While the d-c supply voltage of 12 v is the most desirable, giving full power output, the batteries required may be of some concern to the reader. Because of the intermittent use of a megaphone, however, the battery, B, may be small in size. For example, it can consist of 8 Type-D flashlight cells connected in series. In intermittent regular daily use, such cells have supplied the 150 ma for a month or more.

Power-Type DC Amplifier

The 2N255 power transistor has a base-to-collector current amplification factor **(beta)** of 30 to 50. This varies, of course, with the amount of external collector resistance employed in a circuit but has been found by the Editors to hold reliably to 25 over a wide range of practical, low-valued load resistances.

Figure 5 is the circuit of a single-stage dc amplifier utilizing the beta of this power transistor. The reason for using a power transistor in an amplifier of this type is to provide high output current. Here, the maximum value of the ouput current is ¼ ampere when the external load resistance is low (10 ohms or less). An input-current swing of 10 ma will produce the output-current swing of 250 ma. With zero input signal, the static output-current level, due entirely to the cutoff current of the transistor, is approximately 1 ma, increasing as the resistance of the signal source is raised.

D-C Relay Amplifier

One of the immediate practical uses of the high current gain of the power transistor is the operation of a heavy-current d-c relay from a low-current source. Figure 6 shows a dc amplifier circuit of this type in which the output current of a 2N256 transistor operates a 2½-watt relay from an input signal of only 10 milliamperes dc.

At 12 volts d-c collector potential, an input-signal of 10 ma produces a

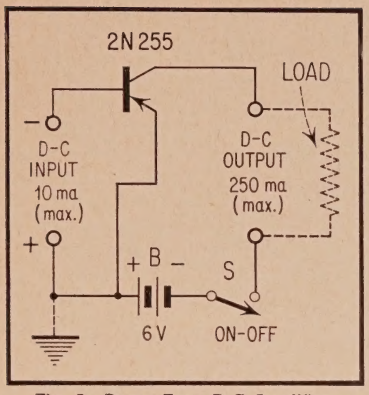

Fig. 5. Power-Type D-C Amplifier.

collector current swing of 250 ma, sufficient to pick up the relay. Zer-signal static current through the relay coil, due entirely to the cutoff current of the transistor, is approximately 1 milliampere.

Higher-powered transistors will permit operation of heavier-current relays.

Constant-Current DC Supply

Constant direct current is required in the testing of semi-conductor devices and non-linear resistors. These components include transistors, diodes, rectifiers, thyrite, thermistors, tungsten filaments, etc. Certain tube-type constant-current supplies have utilized the constant-current characteristic of pentode plate current.

Figure 7 shows the circuit of a simple constant-current supply similarly utilizing the constant-current collector dc characteristic of the common-base transistor circuit. The 2N68 pnp transistor provides a maximum output current of 300 ma when operated with a heat sink, and 200 ma when operated in free air. The current regulation holds over a wide range of load resistance. The number of decades of resistance over which the current is constant varies, of course, with the current level.

The output current is set to a desired level by means of rheostat R_1. Current-limiting resistor R_2 is included for protection against excessive current flow when R_1 is at its zero-resistance position.

Instead of battery B, the 12-volt source may be a semiconductor rectifier-type ac-operated power supply.

Electronic Load Resistor

The tube-type electronic load resistor is a well-known device for testing d-c power supplies. It consists essentially of a tube (or several tubes connected in parallel) with a variable grid bias voltage. The d-c output of the power supply under test is applied to the plate of the tube, and the bias is set for the desired load (plate) current. Thus, the device under test can be loaded to any desired current

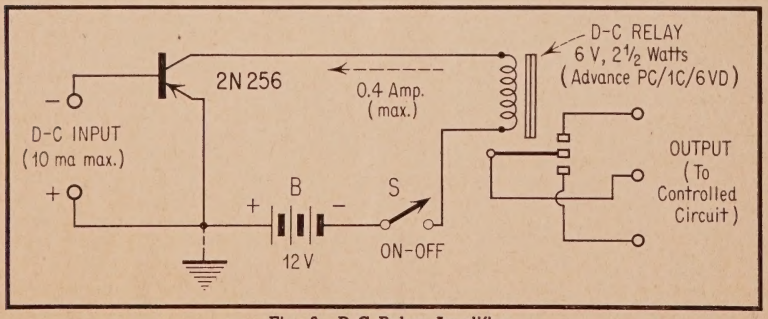

Fig. 6. D-C Relay Amplifier.

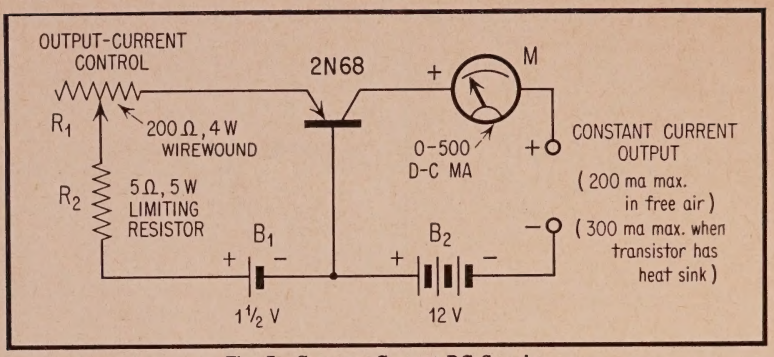

Fig. 7. Constant-Current DC Supply.

level, carefully set by means of the bias control. This electronic arrangement replaces the bulky variable resistors otherwise required in a test of this kind. Because very little current flows through the control, the latter may be a small, smoothly operating rheostat or potentiometer.

The tube-type load resistor has been entirely satisfactory for potentials of 50 to several hundred volts but has had little practical value at lower voltages considerably different from the normal plate voltage of the tube. The power transistor makes possible an electronic load resistor for low-voltage service.

Figure 8 is the circuit of an electronic load resistor capable of operation up to 30 volts and of passing currents up to 800 milliamperes. Heavier-duty transistors (like Delco 2N174; maximum voltage 80 v, maximum current 7 amperes, and collector power dissipation 40 watts) will make higher-performance load resistors. Here, two 2N144 npn transistors are operated in parallel. The collector (load) current is adjusted by varying the d-c base current (from battery B) through adjustment of rheostat R_2. The load current is read from the d-c ammeter, M. Instead of a battery, the bias source may be a miniature, semiconductor rectifier-type power supply.

The maximum current which may be passed through the circuit is 800 ma (400 ma per transistor). This is not the maximum current rating of the transistors but the highest current

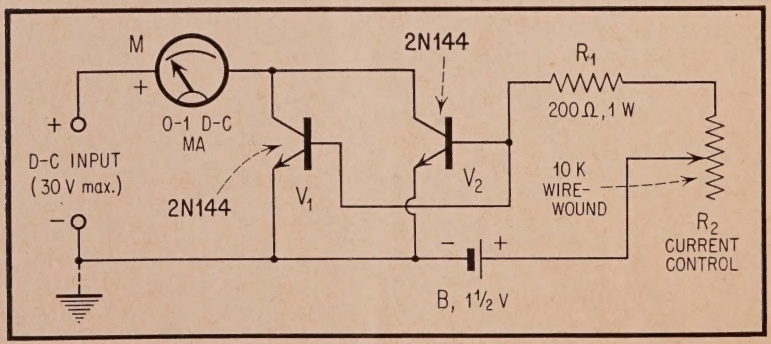

Fig. 8. Electronic Load Resistor.

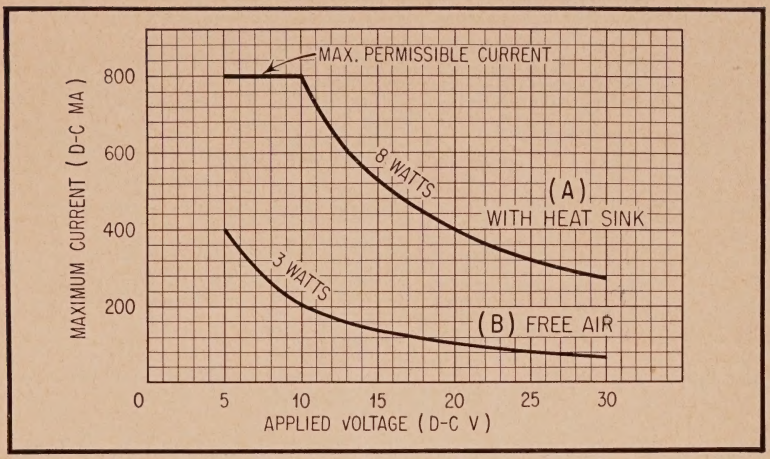

Fig. 9. Constant-Dissipation Curves for Electronic Load Resistor.

that may be drawn within the power dissipation rating of the transistor. The power dissipation must be held within 1.5 watts per transistor when operation is in free air, and to 4 watts per transistor when heat sinks are provided. Curves are given in Figure 9 to show the maximum current that can be drawn at each input voltage without exceeding the power dissipation (maximum) rating for the two transistors in parallel. Thus, the maximum safe current drain in free air is 400 ma when the applied voltage is 5 v, while with heat-sink protection, the maximum allowable current drain is 800 ma at the same 5 volts.

Light-Beam Transmitter

Figure 10 shows a simple circuit for a light-beam phone transmitter of interest to amateurs. The modulated lamp is connected directly in the collector circuit of the 2N68 pnp transistor. The speech signal, delivered by a suitable preamplifier having at least 10 milliwatts a-f output, is applied to the base-input circuit through transformer T.

Rheostat R_1 is set for desired brightness of the lamp. The normal operating current of this lamp is 220 ma but for good modulation of individual lamps, a lower current and brilliance may be required. The audio input signal applied to the base of the transistor in series with the d-c base bias produces amplified collector current fluctuations and corresponding fluctuations in lamp brilliance.

The filament of this particular type lamp follows a-f fluctuations up to several thousand cycles. Because of filament inertia, heavier-duty lamps which would glow at full brilliance in this circuit operate only up to a few hundred cycles per second. The specified lamp has a self-contained lens which is effective only over a short distance. The communication range may be extended considerably, however, by providing a suitable telescopic lens system at the receiver.

Regulated D-C Power Supply

Figure 11 shows the circuit of a voltage-regulated 6-volt, 1-ampere d-c power supply. The 2N356 pnp transistor is the shunt regulator triode. When the d-c terminal voltage rises above the 6-volt zener point of the silicon junction reference diode, D, the latter conducts sharply, passing a current into the base of transistor V.

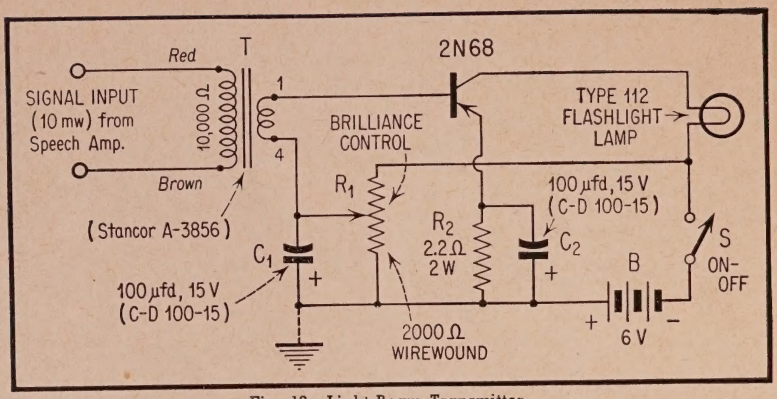

Fig. 10. Light-Beam Transmitter.

An amplified current then flows into the collector, increasing the voltage drop across resistor R, and restoring the terminal voltage to its original level. In this way, the d-c output voltage is regulated against fluctuations in either load or supply.

This small-sized, completely tubeless unit supplies 6 volts dc at 1 amperes regulated, and 6.3 volts ac at 3.5 amperes.

Semiconductor Identification

The diodes, rectifiers, and transistors shown in the circuits in this article are produced by the following manufacturers:

D-116G — Selenium Power Rectifier, International Rectifier Corp.
1N437 — Silicon Junction Reference Diode, Raytheon
2N68 — Transistor, Sylvania
2N95 — Transistor, Sylvania
2N101 — Transistor, Sylvania
2N102 — Transistor, Sylvania
2N144 — Transistor, Sylvania
2N255 — Transistor, CBS-Hytron
2N256 — Transistor, CBS-Hytron

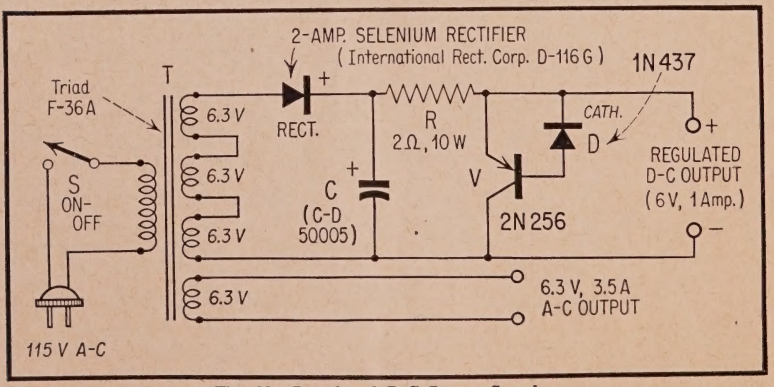

Fig. 11. Regulated D-C Power Supply.

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FOR SALE — GE 260 6-band portable $15; Simpson 260 $25; FM-82 9-tube 21-99 mc tuner $45; xmitter power supply $10; mutual conductance tester $60. Want enlarger, condenser tester, test gear. Al Pratt, 114 W. Lakeview Ave., Milwaukee 17, Wis.

FOR SALE — NRI Radio and TV course complete, test inst. work books, kit manuals, kit parts, in good condition. Don Meek, 210 N. Rock, Sheridan, Ark.

WANTED — Riders 1-5 abridged and 6-20, must be complete and in good cond. State price. Radio-TV Department, Eau Claire Vocational School, Eau Claire, Wis.

WANTED — Job in California and home for my family of six. Allen L. Grant, 15 Sixth St., Melrose, Mass.

WANTED — Six No. 199 receiving tubes. State price. Milton I. Faivre, Box 1862, Tampa, Fla.

FOR SALE — Assembled VF-1 Heathkit VFO, $15; modulator-input transformer feeding pair of 800's to modulation xfmr 200 w., $15; 813, TZ40, T20. Best offer. Joe Jones, Box 232, RD 1, Clarks Summit, Pa.

WANTED — Older type fone xmtr, TVI no problem, rack-panel, with power, l. n., 100 w. up, sturdy, age no problem if good, any tube line-up. Give specs. Thos. E. Hardy, Box 84, Hardy, Ark.

FOR SALE — SCR 59 transmitter, 1918 vintage, perf. cond. L. P. Lastuvka, 1044-19th St. SE, Cedar Rapids, Iowa.

POSITION WANTED — Some TV and radio experience. Wish part-time employment locally as assistant on bench work. Can work evenings and Saturdays. Have car. A. Stellerman, 229 Snediker, Ave., Brooklyn, N. Y.

FOR SALE — Eico voltmeter 221, like new, with instructions and schematic, $20; Capacitest with instructions, $8 COD. S. Rubin, 817 Avenue "M", Brooklyn 30, N. Y.

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FOR SALE — 6 mfd, 1000 v. oil-filled condensers, $2 each; 1922-23-24 copies of QST magazine, $1 each; Motorola car radio, separate spkr, $10. Donald B. Morris, 1111 Alexander Pl., Fairmont, W. Va.

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WANT — Copy of General Radio Experimenter, Nov. 1952. State price. Jacinto Marquez, 813 Gabriela Street, Tondo, Manila, P. I.

FOR SALE — Newcomb P-10-A 10 w. Hi-Fi amplifier, like new, $25. Would like to correspond with builders of transistor intercom described in June 1956 Capacitor. Chester S. Collier, 190 Yoder St., South Bend 14, Ind.

WANTED — Riders receiver manuals, vols. 18, 19, 21 and 22. Must be complete and in good condition. State best cash price. F. C. Davis, 43 Rivermont Dr., Warwick, Va.

TRADE — Gonset Super Six mobile, all band converter or Turner U9S multi-impedance broadcast quality mike, for Hi-Fi record changer. J. L. Smith, 4147 Normandy Ave., Dallas 5, Texas.

SELL OR SWAP — RCA TV course, CREI TV Engineering course, AT1 and 90 w. final with coils and supply. Want comm. rcvr, FM tuner, or RME converter. T. A. Hughes, 116 Bouchard Ave., Dracut, Mass.

SELL OR SWAP — Xformers, input, 100-10,000 cps; output from pair 805's, to 250 w., both W. E. Co.; 2 speakers, PM handle to 250 w. Need mobile converter, VTVM - Heathkit or equal. Walter Boyer, Box 124, Liberty Lake, Wash.

FOR SALE — Meissner 9-1091 AM-FM tuner; H. H. Scott 210-A lab. amp. with dynamic noise suppressor; 12" Permoflux 12-UP-8-1 Royal DeLuxe and GE 12" S-1201-D-7 Hi-Fi speakers. A. Ghirardi, 94 Alpine St., Stamford, Conn.

FOR SALE — Craftsman RC-1 AM-FM tuner, $45; GE ST-5A marker and ST-4A sweep, lab. equip. complete with 11-channel xtals, $650 FOB. R. H. Hall, 604 Tarento Dr., San Diego 6, Calif.

FOR SALE — 2 ATR 110-B inverters, input 110 DC, output 110 AC, 500 w. int., 350 cont., $30 each, or make offer. Charles De Peri, 9 Alabama Avenue, Paterson 3, N. J.

FOR SALE — Motorola 601EM car radio with head, $35 FOB; Rider manuals 1-4, 7, 9, 10, 13 to 22, $7.50 and $10 each or $85 for all. Werner H. Weiss, Riverside Ave., Merrill, Wis.

WANTED — Operating instructions and schematic on RCA manufactured Rider Chanalyst No. 162. Thomas Elwood, 22 Butler Pl., Rosebank 5, Staten Island, N. Y.

WANTED — Short-wave receivers, transmitters, dynamotors — surplus new, or used — for cash. North Radio Co., 62 Cortlandt St., New York 7, N. Y.

WANTED — HQ120X or HQ129X in usable cond. Have HRO coils, antique radios to dispose of. Carl Stone, Box 86, Crossfield, Alberta, Canada.

SWAP — Ampro sound projector with accessories; Revere C-29 16 mm magazine load, 3 lens movie camera with accessories. Value $595. Will deliver and demonstrate where possible. Want Viking, Valient or simlar transmitter. M. Feigenbaum, 160 West Euclid St., Hartford, Conn.

FOR SALE — 15" Westinghouse color TV, in very good cond. $200. Liebrecht Televison, Ottoville, Ohio.

SELL OR TRADE — Rek-O-Kut C-7 console cabinet with 16" turntable, three 105-line leadscrews: a 0-1, 1-0 and 1-0 with spiral gear attachment, re-recording turntable and pedestal, originally $250. Make offer. W. S. Cook, 22703 Eastwood, Torrance, Calif.

FOR SALE — Coyne Practical Radio-TV (5 vol.) and Coyne TV Cyclopedia (6 vol.), $6.50 takes all; Supreme 1948 TV manual, $1; Supreme 1941 Radio, 50c; Audel's Practical Electricity, $1.50 plus postage. G. P. Oberto, 6731 Patterson Ave., Richmond 26, Va.

WANTED — VHF and UHF grid dippers, wavemeters, freq. meters used lab type test equip. of all types, transmitters and receivers for 465 mc band. Slim's, 2025 Sunkist Ave., Waukesha, Wis.

FOR SALE — Esterline-Angus LR wall 10 ma DC recorder with built-in bridge for monitoring approx. 140 v. AC, spring drive or 48 v. DC motor, excellent condition, $150. Emil Backstrom, 5235 North Winthrop Ave., Chicago 40, Ill.

FOR SALE — Back issues of C-D Capacitor from Dec. 1946 to date, 120 copies. Best offer, cash or trade. Walt Bartell, 5536 Wilson Ave., Chicago 30, Ill.

SELL OR TRADE — Astatic AT-1 two-stage TV booster, factory rebuilt, $20; Aeriola Sr. one-tube antique radio, very early set, $20; photo enlarger, takes 616 negative, $22 postpaid. Want antique auto items. Harold Garrett, 711 South New York, Sedalia Mo.

FOR SALE — Several like new cartoned 2-10-20 meter beams. Local only. G. Samkofsky, 201 Eastern Pkwy, Brooklyn 38, N. Y.

FOR SALE — Stancor PT8311; Thor T19F88; GE cond. No. 23F374 8 mf., 1500 v. DC. G. D. Johnson, 117 No. Park Lane, Knoxville, Iowa.

FOR SALE — RCA leather-covered 7-band Portable Strato-world receiver 3BX671, $75. C. L. Gemmill, Box 3254, Charlottesville, Va.

SELL OR TRADE — Complete R-T-S radio-TV course less kits. Want typewriter, guns, or what have you? E. A. Sawyer, Box 346, Marshall, N. C.

SWAP — Hi-Fi GI 12" turntable with heavy duty 4-pole induction motor 16 to 85 rpm, with Astatic 12" arm, dual sapphire needles. Trade for test equip. Barbara Pillar, 451 Thieriot Ave., Bronx 72, N. Y.

SELL OR TRADE — Perfect GE UHF-91 tuner complete with instructions. Want multimatch modulation transformer 125 w. approx. A. Tamburino, 111 South Crescent Dr., Rome, N. Y.

FOR SALE — Radio & TV servicing books, excellent cond., worth over $30 when new. Sell the lot for $8.50 plus shipping. K. A. Morris, USNAS, Columbus 19, Ohio.

WANTED — Used power xformer for 12" Olympic XL 210. Information in Sams Photofact set 109 folder. Will pay cash or trade. Maurice's Radio & TV, 22 Arnold Ave., No. Smithfield, R. I.

WANTED — Sams Photofact Library. All or part in good cond., reasonably priced and if in file cabinets or binders. Local preferred. H. L. Bouchillon, 202 Brown St., Carrollton, Ga.

SELL — Auto radios complete and in working condition: '50 Chev, '50 Buick, '48 Olds, '48 and '51 Nash. $40 takes all. Stanley Zuchora, 2748 Meade St., Detroit 12, Mich.

FOR SALE — Zenith TV service factory manual, $5; Frigidaire service manual covers all appli., $10. Both plus postage. F. A. Atherton, 5 Fifth Ave., Shrewsbury Mass.

FOR SALE — 3" scope $15, 5" scope $20, need some work; R57 ARN-5 $5; BC-222 $5; TU-9-B $2; UHF converter RC-53 $10. All fob. Charles B. Cerates, Rt. 1, Box 1098, Auburn, Calif.

WANTED — Sweep generator for radio IF alignment work. State model, cond., and price. Will sell unused pix tube checker, $25. George Bose, 1531 Oxford Rd., Wantagh, N. Y.

FOR SALE — 2 Philco UHF UT26 converters part 43-7146. Both for $15. Strader's Radio-TV, 1217 Myrtle Ave., Danville, Va.

NEED — 80, 40, and 20 meter coils for Hallicrafter HT-6 xmitter; PR-9 152-174 Mc FM rcvr; 8mm Art films. Will sell 2 Shure Unidyne 55 mikes complete with cable xformers (like new); Simpson 240 multitester $15. W. W. Cashwell, 213 S. Woodlynne Ave., Tampa 9, Fla.

URGENTLY NEED — QST Dec. 1915 and full year 1916, ARRL Handbooks vols 2, 3, 4, 5, and C-D Capacitor vols: 1 — '37, 2 — '38, 3 — '39, also issues of Wireless Age. Bob Jones, 713 Front St., Catasauqua, Pa.

SELL OR SWAP — Mobile 6v, 10 w., 152-162 Mc, xmitter-rcvr, complete with mike, antenna and cables. $75. Bill Dore, 276 Gilmore St., Williston Park, N. Y.

WANTED — McElroy 3-button tape puncher for cutting Wheatstone tape. Cash or trade. Oleg Kolen, 447 W. Genesee St., Syracuse 4, N. Y.

WANTED — Schematic for Sparton power converter 301 manufactured in middle twenties. James Hill, 110-26 175th St., Jamaica 33, N. Y.

SWAP — T17 hand mike and T30 throat mike for 0-1 or better milliammeter. W. McKay, 198 Fairfield, Kenmore 23, N. Y.

WANTED — Older type prewar six-band ham rcvr. Cheap for cash or? H. L. Anderson, 104 Ocean Ave., New London, Conn.

FOR SALE — National 98 amateur rcvr and matching speaker also Knight 50W allied xmitter. Both in excellent cond. $160. Raymond Merz, 2594 Titus Ave., Rochester 9, N. Y.

FOR SALE — NC 88 in very good cond., $60; also 40 w. all band xmitter Fone and CW. Best offer, local preferred. M. Javerbaum, 11 Hobson St., Newark 12, N. J.

WANTED — Antique radio tubes. Harry Williams, Pleasant Hill, Mo.

FOR SALE — HT-9 Hallicrafters xmitter in very good cond. with 10 meter coils. $125. Joseph V. Hellmann, 65-33 78th St., Middle Village 79, N. Y.

SELL — QST January 1947 through March 1957 inclusive as one transaction. Stuzbach, Malmros Ter., Poughkeepsie, N. Y.

WILL TRADE — Sarkes Tarzian UTP1 single channel UHF converter. For code course or radio books. Joseph A. Covolo, 3823 N. Sheridan Rd., Peoria 5, Ill.

FOR SALE — AC-DC table model radios, older model tubes, AC dynamic spkrs, and other electronic equip. L. Goldstone, 1279 Sheridan Ave., Bronx 56, N. Y.

WANTED — Western Electric 9-A or 9-B transcription cartridge. Have transcription library for sale in metropolitan area. Sam Kiamie, 930 Grant Ave., Pelham Manor, N. Y.

SELL OR SWAP — Heathkit linearity pattern generator, LP-1. Leo W. Brandt, 11509 Oelke Rd., Maybee, Mich.

FOR SALE — Like new Eico-950A resistance and capacitance tester, $15; Alliance Casamatic booster list 3450, $6 less tubes; Audels Radiomans Guide, $3; Coyne TV Cyclopedia, $4.50; 20 Basic Points for TV Receiver Service 75 cents. George E. Buck, 224 Waverly St., Providence, R. I.

WANTED — BC 348. A. E. Lamping, 133 Ivory Ave., Pittsburgh 14, Pa.

WANTED — Good communications rcvr and good all band xmitter. Will sell Thordarson 70 w. CHT multi tap mod. xformer and 750 and 1000 v. 500 VA power supply. W. A. Zuehlke, 3799 Medina Rd., Akron 13, Ohio.

SELL OR TRADE — Instructograph, 6 reels, Meisner 3BK SW rcvr with coils, 1950 Buick radio. Want Hickok tube tester, 5" scope or other test equip. Paul Pancio, 1009 Homer St., Olean, N. Y.

SWAP — 3" square 0-1 Ma, 2" round 0-50 v., 2" round 0-50 v. plus 0-50 amp. meters, 2-7/16", 1-3/8" spintites, 2 phono motors, Miscell flashlight bulbs; Rider's file 41. Homemade 5 tube signal chaser. Chas. Elgasser, 1920 Fern St., San Diego 2, Calif.

TRADE — RCA 813 and 815; 2-NU 832, 2-816, 2-807 unused tubes; Bud 10, 20, 40-meter osc-buffer coils 75 wt. Trade all for tape recorder or disc recorder with amplifiers in good cond. Harold Bower, Everest, Kan.

FOR SALE — Back issues of technical journals and technical books. Send for list. W. Skalski, 280 Carlton Ave., East Rutherford, N. J.

FOR SALE — Lysco 600G xmaster with reactance modulator and low pass filter, Guaranteed no TVI 160-10 meters. $65; unused General radio variac 2KVA, 115 v. single phase, 60 cycle, 18 amp, type 100-Q $25. Gene Reynolds, 4063 Lasher Rd., Drexel Hill, Pa.

FOR SALE — All kinds of airborne radio equip., lab test instruments and government electronic surplus equip. Sid Gordon, 215 Rochester Ave., Brooklyn 13, N. Y.

FOR SALE — Heath Antenna Coupler very reasonable shipped postpaid. J. Coffield, 1731 West 1 St., Brooklyn 23, N. Y.

FOR SALE — Sams Fotofacts, $1 each; also have C-D Capacitor magazine from start to finish. E. N. Christner, 313 Crawford St., Middletown, Butler Co., Ohio.

FOR SALE — S-38 Hallicrafter, Anchor booster and Sutton booster, all in good cond., $15 each. George's Radio Repair, 3317 East St., Pittsburgh 14, Pa.

FOR SALE — ATR inverter model RHF 125 w., and Shure 55 dynamic mike. Both in new cond., $35 each postpaid; hundreds of copies of QST and CQ; amateur xtals; etc. Want early auto items, books, license plates before 1920. Bob Schill, Box 412, Hinsdale, N. H.

FOR SALE — About 1000 good radio tubes, mostly used old types, all numbers. Will not ship. Make offer. William H. Henshow, 46 Front St., Tarrytown, N. Y.

WANTED — Radio Handbook by Editors and Engineers 12, 13, 14, and 15. Editions; Cornell-Dubilier TR-2 rotor; Eimac 304TLs. Will sell UTC S22 xformer. C. Borysevich, 1066 President St., Brooklyn 25, N. Y.

FOR SALE — Emerson 3-way portable excellent cond., $8; Philco auto radio, $7.50; RCA chassis model TC166, $5. All COD. V. Kozma, 12450 NW 5 Ave., Miami 50, Fla.

FOR SALE — Tubes: GE-6SA7, 2-12SA7, 7-12SQ7; Ken-Rad 6V6; 2N-U 35 L6; RCA 45Z3. All perfect, $11 for all. Edward Summers, 3605 Janet Rd., Silver Spring, Md.

WANTED — CRT tubes 16WP4A and 8BP4. Pay Cash. C. F. Albertoni, 2629 Paxton Ave., Akron 12, Ohio.

SELL OR TRADE — ARC-5 (7-9.1 Mc) converted, with tubes, $5; BC-457A (4-5.3 Mc) unconverted, with tubes, $4; Johnson heavy duty xmitting key with Navy type handle, $2. Want portable typewriter in good cond. Joseph DiTucci, 234 Parkway, Rochester 6, N. Y.

FOR SALE — Heathkit signal generator, signal tracer, and VTVM to best offer. Milo Flagel, c-o Muley's, Omak, Wash.

SELL OR TRADE — Ansco 35mm color film, sufficient for 350 reloads, indoor and outdoor types, stored under refrigeration in bulk spools. Want TV test equipment, tape recorder. Joseph Teltsch, 1831 Southern Boulevard, Bronx 60, N. Y.

FOR SALE — DX20 excellent cond., $35 and 1. n. S-33A, $75. Both with key and crystals or sold separately plus shipping. Lewis Gould, 159 Cuthbert Rd., Kew Gardens 15, N. Y.

FOR SALE — BC-375E xmitter, CW and phone; 7 tuning units, good for parts; antenna tuning unit; Dynamotor — supplies 1000 v. at 350 Ma. Make offer on all or part. Irv Englander, 3558 Washington Blvd., Cleveland 18, Ohio.

WANTED — Back issues of C-D Capacitor — November 1954 and April 1953. F. I. Schiel, 615 Glenwood St., Waterloo, Iowa.

FOR SALE — NRI 1942 radio course for best offer - also 1955 Christy Appliance Repair Course, $25. John Laflie, 6146 S. Kenneth Ave., Chicago 29, Ill.

FOR SALE — NC 98 and Johnson Matchbox like new, $150 plus shipping. Fred Mayo, 510 6th Ave., Antigo, Wis.

FOR SALE — 21" DeVry TV rcvr with cabinet. Played 3 weeks. Less than cost. Marvin L. Boehm, Radio-TV Service, Sherwood, Ohio.

FOR SALE — 2 UHF all channel tuners wire in type models — 36 F/G standard coil strip, one each Zenith S18337 and J54 and 36 strips, indoor UHF antenna. All $35 or swap for RF sweep generator. F. O. Copithorne, 108 Lawrence Ave., Ferguson 21, Mo.

FOR SALE — Link Mobile xmitter for 10 meters with mike and 6 v. dynamotor, $15; 3" 0-150 v. A-C meter, $2.50; 6 pole, 12 position miniature ceramic tap SW., $2: partially converted PE101C, $4. George Hausske, 1922 E. Indiana St., Wheaton, Ill.

FOR SALE — Sylvania 220 tube tester new cond., in good working order, $65. George Masek, Marissa, Ill.

SWAP OR SELL — Radio and TV News, April 44 to Oct. 49; Service Magazine, Nov. 45 to Jan. 51; numerous other copies including Radiocraft, Radio Electronics. All FOB. Want US stamps prior to 1940 or $10. W. L. McKinley, 5956 N. Haven Dr., North Highlands, Calif.

SALE — Odd tubes such as GL2D21, 415A, 408A, 7S7, 7H7 and many others, all in original boxes; also VAC tube type relays such as 276G, etc; radios. W. J. Erb, 3064 "A" St., Philadelphia 34, Pa.

FOR SALE — Old Remington 10 standard typewriter, $7.50, local only. A. Gilbert, 1697 Andrews Ave., New York 53, N. Y.

FOR SALE — TV booster, $10; UHF converter, $6; channel 4 yagi antenna, $7; Circle X antenna, $10. Frank Gedaro, 49 Newbury St., Portland 3, Maine.

FOR SALE — TV service store, knicknamed "Radio Row" section, small apartment, driveway, good will sale. Paragon TV and Service, 170-26 Jamaica Ave., Jamaica 32, L. I., N. Y.

SELL — 20 assorted AC-DC radios in need of repair, many with all tubes, same for 4 TV sets; 200 unused phono records 10 years old. A. Spivack, 1120 E. 165th St., Bronx 59, N. Y.

SELL OR SWAP — Sonar XE-10 exciter, $10; Link mobile xmitter 10-UBX, $15; four 12 mfd. 2000 v. GE oil filled capacitors, $6 each. Want 35mm camera or VTVM. J. Pyryt, 192 Norman Way, Paramus, N. J.

SELL OR TRADE — Complete ICS course in Powerplant Engineering, $25 or? Also Diesel Engineering course, $10 or? Want NRI or RCA Radio and TV course, test equip., semi-auto bug. P. Dumais, 36 Parker St., Newton, Mass.

WANTED — Hammarlund HQ-129X communications receiver in perfect cond. Have first ten vols Sams Photofacts to trade on same, or will pay cash. R. W. Daniels, 1418 Division St., Hopkins, Minn.

FOR SALE — Hickok 600A tube tester; service mags and literature; resistors 2c each; midget var. condensers; high grade condensers and parts. John Kadletz, Chatfield, Minn.

FOR SALE — Heathkit dynamic tube checker, condenser checker, and TV alignment gen.; Eico 5" Scope 425 and VTVM 221. Best offer. Tony Furdyna, 75 Francis Ave., Sharon Hill, Pa.

SELL OR SWAP — Emrick 5-in-1 combination woodworking machine with 1/4hp capacitator motor and saw blade for tube tester and signal generator in good cond. Local preferred. Anthony Cincotta, 541 Union St., Carlstadt, N. J.

SWAP — Complete (Commercial Trades) TV course with test, inst., and 21" TV, books. Want tape recorder or vocaline 2-way radio gear. Vernon Kroh, New Salem N. D.

SELL — EV1000 Clipper $10, Clipper-Filter as Jan. QST Guaranteed $10, 3 EL 20 meter beam $33, BW TVH 20 meter coil $3.50, 40 through 10 pre-amp boosts at least 25 db $13. P. Bittner, 55 E. Crystal Lake, Crystal Lake, Ill.

SELL OR TRADE — RCP ohmmeter, $4; Maico hearing aid like new, $20; Weston analyzer, $50 or trade for S-20-R rcvr; unused Heathkit AM-1, $12; TV booster, $5; 20 assorted xformers, $15. Myron L. Braun, 202 Howard Street, Bellevue, Ohio.

FOR SALE — TS-1A Heathkit alignment gen. and marker with instructions $20; Riders vols. 7 to 14 incl. unused $60; Eico 1040 battery eliminator and charger like new, $15. All FOB. Robert Binkowski, 409 Bohland Ave., Bellwood, Ill.

FOR SALE — Radio-TV Shop in center of 10 growing New Jersey communities. Rent entire building, family quarters in rear. Small investment, business established 2 years and still growing. F. J. L. Electronic Service, 554 Union Ave., Somerville, N. J.

FOR SALE — Perfect RCA WO-91A, Bk-Wh-Color, 5" scope, includes probe, cables and inst. Best offer over $220 FOB. Shipped in original carton. Joseph Allshouse, Munderf Star Route, Brookville, Pa.

FOR SALE — Hallicrafters S40-A, 4 bands built in record player excel. cond., instruction manual, service notes, $55. R. Garcia, 300 West 17th St., New York 11, N. Y.

FOR SALE — Concertone 1501D tape recorder dual tracks, 7½ and 15 ips. speeds, portable case, amplifier, spkr, excellent cond., $175; Pentron T-90 dual speed dual track recorder, perfect, $95. All fob. V. Maycher, 102 Morris Ave., Garfield, N. J.

WANT — Hickok test equip. Swap Heath O-11, TS4-A, LG-1, IT-1, TS, V-7A, AV-3, C-3, MM-1, Mall electric 7¼" hand saw, Sunbeam sander and sabre saw, l. n. Model plane motors. Hugh G. Stacy, 4 Dartmouth St., Natick, Mass.

FOR SALE — Unused PE-110A in crate, $55, less crate, $45; Millen R9ER with coil, $19; freq. standard 10 Kc and 200 Kc, $25. Need General Radio 1140A wavemeter. Philip D. Greenway, 2318 21st Ave. South, Birmingham 5, Ala.

WANTED — To exchange swap list. Have electronic equipment to trade for TV's. Karl G. Muck, RFD 2, Warsaw, N. Y.

SELL OR TRADE — SM3 portable gieger counter, with batteries and headphones, 0.2 mr/hr sensitivity. Best offer or trade for 8mm movie or 35mm still equip. E. L. Freud, 206 Manhattan Ave., Hawthorne, N. Y.

FOR SALE — American Bosch 12v 50A mobile power generator and regulator, $75 plus shipping charges. Cost $130. Fred A. Haight, 9875 Ozga Rd., Romulus, Mich.

SELL OR SWAP — Hallicrafters SX42 rcvr less speaker. Good cond. Want Gonset communicator. A. Franz, 1158 Northampton St., Holyoke, Mass.

SWAP OR SELL — Never used 17 jewel watch, portable typewriter, high quality camera, instruction books. Want sig. tracer, sig. gen., capacitor checker. G. Dukhov, 605 West 137 St., Apt. 53, New York City, N. Y.

FOR SALE — Wagner-Nichols microgroove disc recorder, lathe feed screw type $75; York Tenor saxophone $50; Pickering D-220 miniature diamond cartridge, $15; Motorola car radio and control head, $10. All excellent cond., priced fob. Marilyn Phillips, 311 Penfield, Rockford, Ill.

WANTED — To buy several 17" and 21" table model TV receivers. Cabinets must be A-1. Sets do not have to be in working order. Kenneth P. Branscombe, 119-50 234 St., Cambria Hts. 11, L. I., N. Y.

POSITION WANTED — Young man with some experience in ham radio, audio, TV camerawork and lighting, would like job on technical staff of TV station. Robert Green, 924 Vineshire Rd., Cleveland Heights 21, Ohio.

FOR SALE — Heath TS-3 signal sweep generator with 4.5 Mc plug-in type crystal, plus all technical data. Never used, reasonable, make offer. Al Marschner, 35½ Quabeck Ave., Irvington, N. J.

FOR SALE — Eico VTVM 221 signal gen. 315, scope 5 in 425 with inst. manual, all $100. Like new. Herbert Bernstein, 1689 St. Johns, Brooklyn 33, N. Y.

FOR SALE — 3 perfect Heath instruments: sweep gen., $45; condenser checker, $18; CRT checker, $20. V. R. Valley, 4318 Banks St., New Orleans, La.

SWAP — 8BP4 videotron TV tube, good cond., for 7JP4 TV tube in good cond. Joseph Poganik, 21-51 35th Ave., Long Island City 6, N. Y.

WANTED — Hallicrafters S-21 5-10 rcvr, must be clean. Fred E. Nolkemper, 3206A Kosssuth Ave., St. Louis 7, Mo.

WANTED — Back issues C-D Capacitor Oct., Nov., and Dec. 1937; June and and Dec. 1939; also Radio News, Aug., Sept., Oct. 1921, and 1929 ARRL Handbook. J. Simpson, 85-39 152nd St., Jamaica 32, N. Y.

WANTED — Model 112B Scott Dynaural Noise Suppressor in working condition. State price less tubes, packed for mailing. H. W. Burkell, 5805 110th St., Edmonton, Alberta, Canada.

SELL OR TRADE — Radio and TV tubes for others. American Beauty 230V soldering iron, $3; Regency booster, $4; hand operated mimeograph machine, $25. J. Andrews, 740 Maple St., Bethlehem, Pa.

WANTED — Used communications rcvr, state model, cond., general specifications, and price. Must be reasonable. Al Rosen, 1125 Circle Dr., Las Cruces, New Mex.

WANTED — FCC approved 2-way communications equipment 25 w. or more in 468-470 Mc band. Give price and condition. Ted Nevola, 146-43 182 St., Jamaica 13, N. Y.

FOR SALE — Bug code key, $10; 12-station intercom master, $15; Mallory 6RSD 6vdc power supply, $15; Heath electronic switch, $15; Precise 635 sine-square-pulse generator, $25. All excellent cond., FOB. V. R. Hein, 418 Gregory, Rockford, Ill.

FOR SALE — Heathkit TS4 TV alignment sweep generator and marker. Factory aligned in excellent cond. with 4.5 SMC crystal and output leads. $45 plus postage. J. W. Paini, 314 Bay 14 St., Brooklyn, N. Y.

FOR SALE — National NC-300 with spkr and homemade 100 kc crystal calibrator, $300; Heathkit antenna tuner, $12. You pay shipping. Howard Haftel, 1651 Montgomery Ave, Bronx 53, N. Y.

WANTED — Old cabinetmaker's tools any cond., Circa 1875. Complete chest or individual tools. Will trade Knight in-circuit capacitor checker, Worner electric eye bell ringer, or cash. A. Cantor, 1264 Rhinelander Ave., Bronx 61, N. Y.

WANTED — June issue of Radio-Electronics, cond. not important. Send price. Howard A. Kiker, 126 Rudderow Ave., Mount Epheraim, N. J.

FOR SALE — Beckman G Ph meter in perfect electrical cond., without electrodes and batteries, $25 FOB. Will consider trade. Gerard A. Baldauf, 3137 Philmont Ave., Huntingdon Valley, Pa.

WANTED — Heath OL-1, Waterman, or other small 3" scope. State model, price, cond., and dimensions of cabinet. Technical specifications desired if not Heath. Robert Allington, Lincoln Gen. Hospital, Lincoln, Neb.

FOR SALE — Eico 315 signal generator, $20; Gonset noise clipper, $3. A. L. Jeffrey, 1321 Brinton Rd., Pittsburgh 21, Pa.

FOR SALE — Heath O-10 scope, factory calibrated, $45; Knight in circuit capacitor checker, $10; Eico 950-A capacitance bridge, factory wired, $15. All C.O.D. Redd's Radio & Service; Box 12, Union Furnace, Ohio.

TRADE — Perfect DR-299 Detectron Nucliometer and Geiger counter, with all accessories. Cost $545. Want SX600, ARC-1 ARC-3, SP-600, or what, of equal value. Western Radio Electric, 1260 W. Broadway, Missoula, Mont.

WANTED — Tubes: xmitting, receiving, special-purpose industrial types such as Klystrons, etc.; Hickok tube checkers, Variacs, etc. Cash or swap for choice equip. B. N. Gensler, 56 Crosby St., New York 12, N. Y.

SWAP — 2" x 2" 35mm Spartus projector PB-200, 2 perfect 12" GE PM speakers. Want any make tape recorder, 7½ x 3¾ screen in working order; also 7JP4-CRT. Anders Radio and TV, 33 Adams St., Nelsonville, Ohio.

FOR SALE — Collins 310-B exciter, complete, like new, instruction manual, antenna tuner, etc. $150 FOB. Walter L. Babcock, 405 Sayles St., Oneida, N. Y.

FOR SALE — Heath AT-1, QF-1, V-4 VTVM, Eico 5" scope, Precision E-200 RF generator, NC-98, SW-54, Viking VFO, Gonset Tri-band, 6 v. Dynamotor, complete set of supreme diagrams for radios. No reasonable offers refused. H. F. Burnup, Box 136, NAS Cecil Field, Fla.

FOR SALE — ½ K.W. Rack xmitter 20/40 phone and CW complete with 20/40 meters BC 459A use as VFO or xmitter with power supply asking, $75. Make offer. H. E. Ballentine, 248 Harvest Ave., Staten Island 10, N. Y.

FOR SALE — Sams Photofacts 45 through 325 plus 11 older folders with 12 binders, $300; Hickok 288X and 610 generators. Best offer for both. Good cond. T. V. Starcher, Denver Dr., Lake Milton, Ohio.

FOR SALE — Good G.I. recorder-phono assembly, 33⅓ and 78 rpm, with magnetic cutting head-crystal pick-up, $15; Regency RC-600 UHF converter, l. n., $17. Both with instructions. Austin Wardman, 106 Rossmore St., East Pittsburgh, Pa.

FOR SALE — Philco pocket-size scope, $30; 6 pairs phonograph drawer slides, never used, heavy gauge steel with corrosion resistant finish. 18" track length, 14" channel length 60c a pair. D. M. Cuomo, 3023 Radcliff Ave., New York 69, N. Y.

FOR SALE — Riders Manuals, 1 through 13 9 books; signal gen. A.E.I., model A-200. All in good condition, make offer. L. Winans, 14901 Evers Ave., Dolton, Ill.

FOR SALE — Coil sets for Hallicrafter HT17 xmitter. Send stamped, addressed envelopes for price list. Jerry S. Harper, 5240 S. Parker, Chicago 15, Ill.

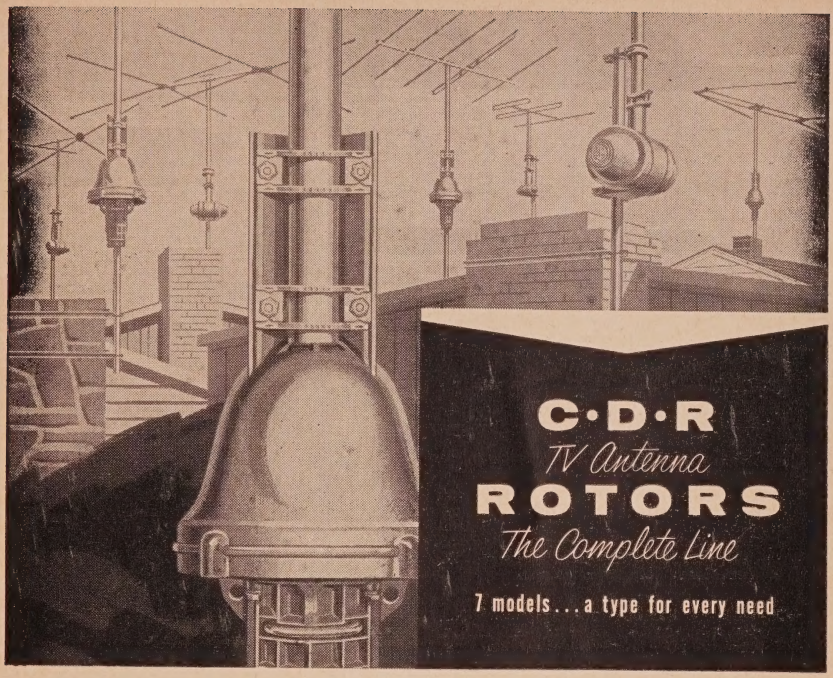
FOR SALE — Heathkit C-2 condenser checker, $12.50; Heathkit GD-1B grid dip meter with additional low frequency coils, $20; Eico 145 multi-signal tracer, $12.50; all with test leads, instruction manuals and first class cond. K. Gambichler, 3201 Hull Ave., Bronx 67, N. Y.

SELL OR TRADE — HQ 129X and other gear for mobile rcvr and equipment. Send your list. Murray Cohen, 2078 Wallace Ave., New York 62, N. Y.

FOR SALE — Home built linear amp 1000 w. power supply, cap. 600 w., $70; SX96 rcvr with speaker, $190; Monimatch, $15; ST203A mobile xmitter, $35; PE103 dynamotor, $20; Gonset 10-11 converter, $15. Arthur Stauck, Jr., 541 Princeton Rd., Linden, N. J.

FOR SALE — Harvey-Wells TBS-50-D complete with H-W VFO, H-W APS-50 power supply and instruction manual. Excellent cond., year old, $130. Accept good rcvr in trade. R. Roske, 45 Hastings Ave., Pawtucket, R. I.

WANTED — For cash — used amateur rcvrs TG34-A or similar code practice set, headphone, keys and bugs. State cond. and lowest price. William Welsh, 1228 Cambridge St., Cambridge, Mass.



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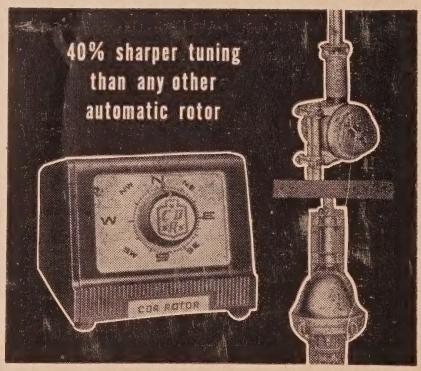

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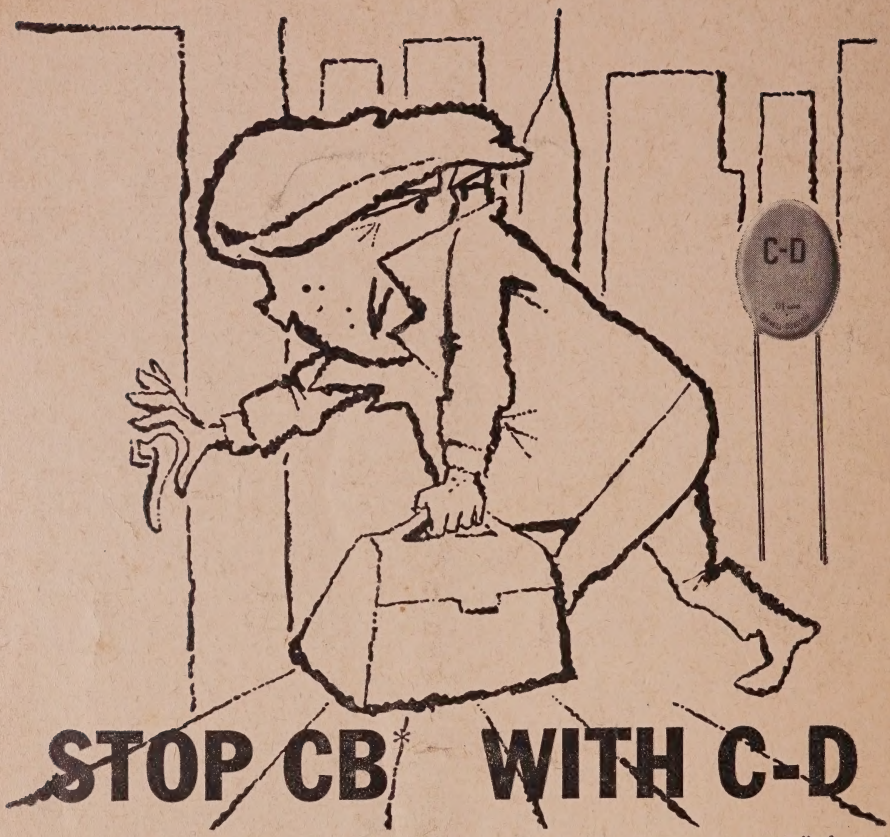

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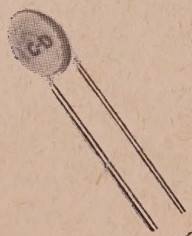

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